decreases directly after waterings, but finally becomes excessive again when the water level is raised and the lower soil becomes saturated by the infiltration of flood water from the rising Nile.

In the Mississippi studies there appears to be no basis, on the whole, for assuming that temperature has any appreciable effect on shedding; but it seems from the data collected that the moisture factor is important, the data showing that an insufficient supply of moisture tends to excessive shedding. There was no opportunity, however, for observing the effect of protracted periods of wet weather, so this aspect remains to be studied. The outstanding feature of the moisture and shedding curves is the apparent relation between that for evaporation and that for shedding, in which a high rate of evaporation and decreased soil moisture frequently correspond to a rise in the shedding curve, if an arbitrarily established period of four or five days is allowed to intervene between apparent cause and effect, or for the action of the stimulus to shedding.

Reviewer's note.—In the study of the relation of weather to such ecological phenomena as the fruiting of cotton, it is unfortunate that sufficient observational data are not available for the establishment of at least an approximate normal curve, to permit of a mathematical correlation of departures from the normal weather factors, and departures from the normal frequency curve. The first flowers appear in a field of cotton from 7 to 10 weeks after planting; and production gradually, but irregularly, increases to a maximum, after which it decreases in like manner to the close of the flowering period. Owing to this fact the advantages of a normal frequency curve are obvious, as by its use the normal increase or decrease in the curve for a particular time period may be eliminated and only the abnormalities considered.—*J. B. Kincer.*

THE BIOCLIMATIC LAW.[1]

By Dr. ANDREW D. HOPKINS, Bureau of Entomology.

[Abstract.]

The normal northward and upward advance of the leafing out of trees, the appearance of insects, etc., in spring, and the southward retreat of phenological events, in autumn, have been the subject of observation for more than a century in the United States. Dr. Hopkins has been particularly drawn to the study of phenology by the value of knowing the time of emergence of certain forest insects and of the hessian fly. His studies which led him to examine planting and harvest dates as well as other phenological dates has placed on a firm foundation the *bioclimatic law.*[2] Dr. Hopkins's own statement follows:

> Variations in the date of a periodical event from a given norm or constant are a measure, in terms of time, of the intensity of the controlling influences and forces as related (*a*) to geographical position, (*b*) to the season, (*c*) to the inherent tendency of species under the same external influences to vary towards early and late individual responses, and (*d*) to early and late responses of individuals of the same variety under varying local influences. The variation from a constant in the date of an event also measures the intensity of the controlling influences in terms of distance as related to feet of altitude or equivalents in degrees of latitude or longitude.
>
> Studies in the application of these principles show quite conclusively that the responses to the controlling influences and forces are in accordance with natural law, in that (*a*) the time of occurrence of a given periodical event in the seasonal activity, or (*b*) the latitude limits of distribution of an organism, or (*c*) its altitude limits, are determined primarily by geographical position. Therefore, *other things being equal*, the variation between two or more geographical positions bears the same proportion to the distance between them, that 4 days of time bears to 1 degree of latitude, 400 feet of altitude, or 5 degrees of longitude [average only for the whole width of the continent]. * * *
>
> As measured in time the variation from the constants is found to range from one to forty, with a maximum of fifty days at certain points along the Pacific Coast. As measured in altitude the variations are from 100 to 3,000, with a maximum of 5,000 feet. In these departures the earlier dates and higher altitudes are the result of accelerating influences, and later dates and lower altitudes are due to retarding influences.
>
> In order to gather further facts and evidence on the variations from the constant and also the rate of advance of the spring season, as revealed by periodical phenomena, observations were begun at Brownsville in southeastern Texas and at Palm Beach and Miami, Fla., in February of the present year (1919). These were continued along routes from Brownsville in a general northeastward direction to the northern borders of the States of New York, Vermont, and Maine, and to above the timberline on Mount Washington, from Miami north along the Atlantic coast to Washington and from Palm Beach across the Florida Peninsula to Fort Wayne, then north to Lake City and west to Pensacola, and return to Washington by the way of Birmingham, Ala., Atlanta, Ga., and Charlotte, N. C. These routes involved a travel, principally by rail, by Messrs. Griffith, Craighead, Snyder, and the writer, of over 20,000 miles and the recording of over 20,000 observations. The data accumulated by these investigations has served not only to verify the facts and evidence furnished by the wheat harvest and altitude limit data but has contributed information toward the solving of many other problems of scientific and economic interest, relating to the application of the law in research and practice. * * *

[1] Jour. Wash. Acad. Sci., Jan. 19, 1920, 10: 34–40.
[2] See MONTHLY WEATHER REVIEW, Suppl. 9, 1918, and *Scientific Monthly* June, 1919, 8: 496–513.

BAROMETRIC GRADIENT AND EARTHQUAKE FREQUENCY.

By T. TERADA and S. MASUZAWA.

[Abstracted from Proc. of Physico-Math. Soc. of Japan, 3 ser., vol. 1, pp. 343–347, 1919.]

For each of a number of areas surrounding a given epicentral zone, the mean barometric gradient (amount and direction) for each of *n* successive years is calculated; the mean of the *n* means is taken, and the departure of each from this general mean found; the product-sum of these departures and the number of quakes originating in the epicentral zone during the corresponding year, divided by the total number of quakes, gives a vector which may be considered in some measure as the most effective deviation of the barometric gradient of that area in causing earthquakes in the particular zone. The mapping of the vectors for each of the areas surrounding the zone throws some light on the general seismic mechanism.

For two epicentral zones of Japan, the data for 1902–1915 show that most of the deviation vectors (pointing toward the high pressure) are nearly perpendicular to the axis of the island, those to the west of a line from Sado to Tokyo being directed more or less toward the Pacific side, and those to the east pointing generally toward the Japan Sea side; the type of surface loading suggested, if applied simultaneously, would be favorable to effect or produce fracture of a fissure located along, or parallel to, this line.—*E. W. W.*

EARTHQUAKE FREQUENCY AND RAINFALL.

In the Tokyo *Asahi* for January 29, 1913, Prof. Omori directed attention to a remarkable coincidence between the frequency of earthquakes as recorded at Tokyo by the seismometer and the total amount of rain and snowfall in northwestern Japan; but was unable to assign a reason for the apparent relationship. According to *Nature* (vol. 91, p. 65, 1913):

> The relationship is borne out by statistics covering the whole of the Meiji era—45 years from 1867. The number of earthquakes recorded annually at Tokyo between 1876 and 1909 is found to be practically in